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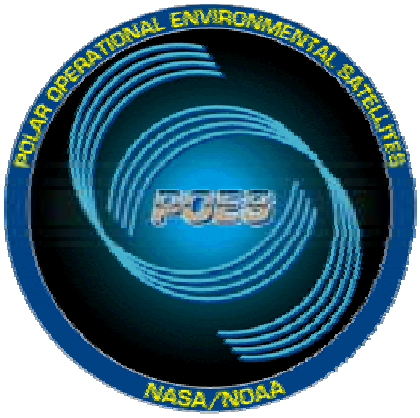
Rev. A

Polar Operational Environmental Satellites (POES)

PROGRAM PLAN



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National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

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Polar Operational Environmental Satellites (POES) Program Plan

Agreements:

A.V. Diaz Director, Goddard Space Flight Center	Date
Ghassem Asrar Associate Administrator for Earth Science	Date
Harry G. McCain POES Program Manager	Date

CHANGE HISTORY LOG

Revision	CCR	Effective Date	Description of Changes
Baseline	1623	8/10/99	
A	1752	9/8/2000	Added change history log; corrected TOC; added 2nd sentence to first paragraph and reworded 2nd paragraph of Section 4.2.1; corrected Figure 3 reference of section 5.2.2; deleted Figure 4 and replaced with new table 2; deleted last sentence in second paragraph of 6.0; corrected section 8.2 CM Procedure reference; deleted 2nd bullet and defined acronym in 3rd bullet of section 17.1; renumbered tables; added AA concurrence to section 18 second paragraph; added two acronyms to section 19; and added pagination.

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1.0 Introduction and Program Overview

1.1 Overview

The main purpose of the POES Program Plan is to establish the following:

a. Program objectives and performance goals.

b. Program requirements.

c. The management organizations responsible for the program throughout its life cycle.

d. Program resources, schedules, and controls.

In 1960, the Nation's first weather satellite, TIROS 1, was built and launched by the National Aeronautics and Space Administration (NASA). Since that time, the U.S. civilian environmental satellite program has been a succession of experimental satellites followed by operational systems. NASA has overseen the development of experimental and research-oriented programs, while the Department of Commerce (DOC) (through the National Oceanic and Atmospheric Administration [NOAA] and its predecessor organizations), has overseen the routine operation of the operational environmental systems. NOAA and NASA have developed a unique working arrangement that integrates the specialized capabilities of each agency in providing space-borne environmental monitoring for the purpose of environmental forecasting.

The Polar Operational Environmental Satellites (POES) Program provides for the procurement and launch of the NOAA spacecraft (NOAA-K, L, M, N and N') and for the procurement of the NOAA instruments for the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) Meteorological Operations (MetOp) spacecraft. POES is a collaborative program between NOAA and NASA. Goddard Space Flight Center (GSFC) has been assigned implementation responsibility for the spacecraft, instruments, and launch services.

POES spacecraft provide global coverage of numerous atmospheric and surface parameters, as well as space environment monitors and an aircraft and maritime emergency beacon system. The data gathered by the instruments are used routinely in numerical weather forecast models to provide weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas; to protect life and property; and to enhance the national economy.

NASA currently manages the development of the continuing series of spacecraft that provides this contiguous series of measurements for operational weather forecasting. After NASA completes its on-orbit checkout of each spacecraft (approximately 21 days after launch), they are turned over to NOAA for routine operational use. Immediate plans call for the procurement of POES spacecraft and instruments for NOAA-L-N' with additional sets of POES instruments to fly on European MetOp satellites.

The nominal operational system consists of two spacecraft in sun-synchronous (7:30 AM and 2:00 PM) orbits providing on-orbit redundancy.

GSFC is responsible for management of the NOAA spacecraft, procurement (including sensors), unique equipment for satellite ground testing, launch site payload processing, initial satellite checkout and evaluation in orbit, and support of the National Environmental Satellite, Data, and Information Service (NESDIS) in the telemetry and command ground system design and development.

EUMETSAT, through a mutual agreement with NOAA, has agreed to provide one of the two satellites in the NOAA mission starting in 2003. This will be accomplished through a European Space Agency- (ESA) procured MetOp series of satellites; NOAA-supplied/GSFC-procured instruments; a EUMETSAT-supplied instrument, the Microwave Humidity Sounder (MHS); and ESA-supplied instruments, which are not directly part of the NOAA operational mission. GSFC will be responsible for the delivery of the GSFC-procured instruments to ESA for integration and assuring proper accommodation of these instruments. (Accommodation is broadly interpreted to include all aspects of systems integration and operation of the instruments and in accordance with meeting NOAA mission objectives.)

NOAA is responsible for the operation of the NOAA-K, L, M, N, and N' system, including determining the need for spacecraft replacement, and for the design, development, and operation of the ground system to acquire, handle, process, and disseminate the data from the sensors. EUMETSAT will be responsible for the operation of the MetOp series. NOAA and EUMETSAT data collection resources will be shared and reciprocal emergency command services will be established. Call up of the MetOp will be based on agreement between NOAA and EUMETSAT. NOAA also provides all ground segment, spacecraft operations and data reduction support.

2.0 Program Objectives and Performance Goals

2.1 Objectives

The systematic observations provided by the POES spacecraft furnish data critical to the Earth Science Enterprise's strategic plan objective of understanding the causes and consequences of long-term climate variations on regional as well as global scales.

In addition, the POES program objectives relate to NASA's objectives as stated in its Strategic Plan. These include providing for distribution of meteorological data to various organizations, improving the capability for forecasting and providing real-time warnings of solar disturbances, and extending knowledge, and understanding of the atmosphere and its processes in order to improve short- and long-term weather forecasts. These meet the Agency's objectives of disseminating information about the Earth system, expanding scientific knowledge by characterizing the Earth system, and enabling productive use of Earth Sciences products in the public and private sectors.

The objectives of the POES Program are to procure, develop, test, and launch an operational polar-orbiting satellite system that will meet the observational requirements as specified by NOAA and to develop and integrate instrument sets for the MetOp spacecraft.

2.2 Performance Goals

The performance goals of the POES Program through the planned launch of NOAA-N' in 2008 are to:

- Meet NOAA's requirements for operational data continuity and cost effectiveness involving maximum use of launched assets.

2.3 Performance Indicators

Successful performance is indicated by:

- Ensuring spacecraft support NOAA's guidelines for launch readiness and planned launch dates.
- The successful operation of each spacecraft for at least two years.

3.0 Customer Definition and Advocacy

NOAA is NASA's primary customer for the POES Program. Customer advocacy is ensured through implementation of responsibilities as defined the Memorandum of Agreement (MOA) between NASA and NOAA for Cooperation in the POES Program (dated April 17, 1998).

4.0 Program Authority and Management Structure

4.1 Authority

Lead Center - Goddard Space Flight Center
GPMC - NASA Headquarters Program Management Council
Program Manager - Mr. Harry McCain

GSFC is the lead center for the POES Program. Program authority is delegated from the Associate Administrator for the Office of Earth Science (AA/ES) through the GSFC Center Director to the POES Program Manager (Figure 1). The HQ Program Management Council (PMC) is the governing PMC for the POES Program.

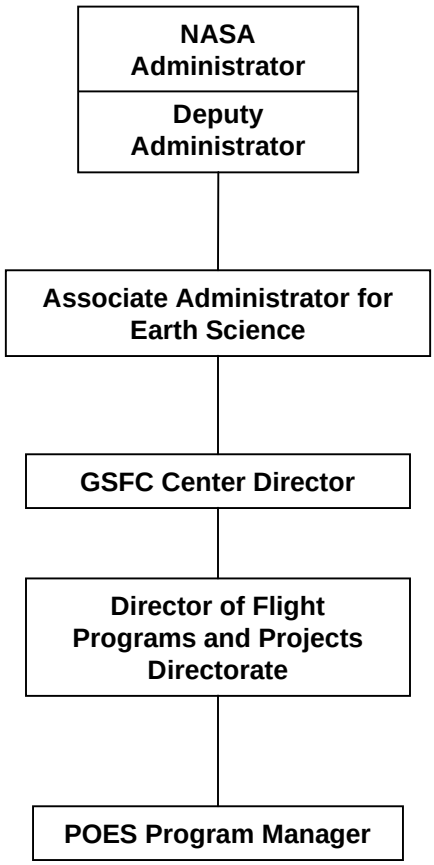

Figure 1. Overview of the NASA Organization for the POES Program

4.2 Responsibilities

4.2.1 Overall Organizational Responsibilities

The AA/ES, NASA Headquarters (HQ), is responsible for overall direction and evaluation of the POES Program. Recognizing that new activities may be proposed to be added to the POES Program from time to time, it is understood that, consistent with NPD 7120.4A and NPG 7120.5A, the formulation activities associated with such activities will be the responsibility of the Enterprise Associate Administrator, with delegation to the Lead Center as appropriate.

GSFC has been assigned lead center responsibility for the POES Program. This includes the responsibility for Program management of the spacecraft, instruments, spacecraft integration and test, launch and on-orbit checkout. Kennedy Space Center (KSC), as a supporting center is responsible for the technical surveillance of the United States Air Force (USAF) Titan II and the NASA Delta II launch vehicles processing for launch.

At GSFC, the POES Program is located within the Flight Programs and Projects Directorate (FPPD). The POES Program staff works with functional GSFC Directorates to plan, implement, and coordinate development of the POES Program. The GSFC program management organization chart for POES is shown in Figure 2.

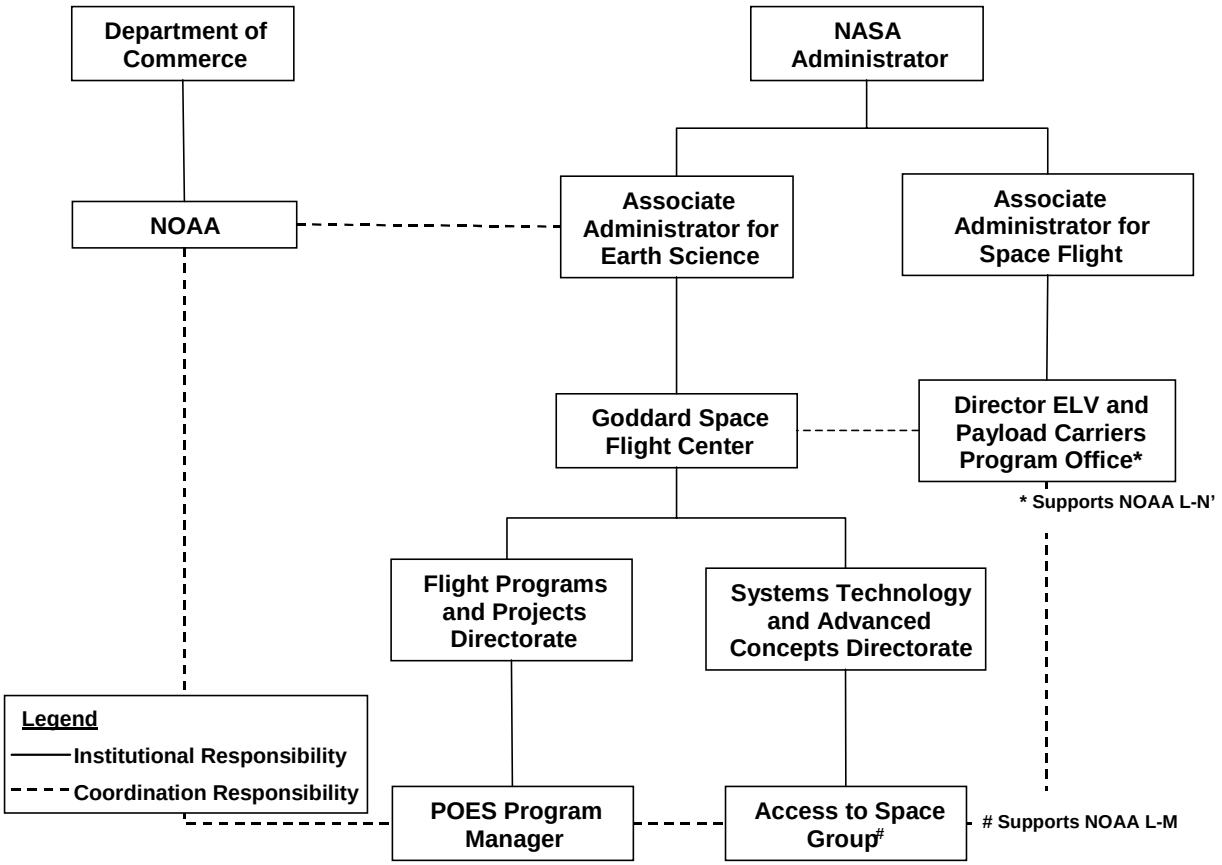

Figure 2. GSFC Program Management Organization Chart for POES

The NASA management responsibilities and procedures for the POES Program are in accordance with "NASA Program and Project Management: Processes and Requirements," NASA Procedures and Guidelines (NPG) 7120.5A. The division of responsibilities between NASA and NOAA are in accordance with the "Basic Agreement Between U.S. Department of Commerce and the National Aeronautics and Space Administration Concerning Operational Environmental Satellite Systems of the Department of Commerce," dated June 17, 1998 and the MOA dated April 17, 1998.

4.2.2 Program Manager

The POES Program Manager is responsible for ensuring the performance of all functions necessary for management of the POES Program. In particular, he/she is responsible for the following:

- Program planning, including recommendation of budget and milestones and preparation of Program Plans.
- Developing, recommending, and advocating the program resources.
- Allocating the budget.
- Establishing support agreements.
- Executing and overseeing the Program Plan.

- Controlling of program changes.
- Approving Program Plans and associated changes.
- Reviewing and reporting program performance.
- Complying with applicable federal law, regulations, executive orders, and Agency directives.

The Program Manager has full authority to carry out these functions, subject to limitations established by the Director of the FPPD and the GSFC Director. The Program Manager discharges his/her responsibilities with the assistance and support of individuals and organizations assigned either administratively or functionally to the program management organization.

5.0 Program Requirements

5.1 Overview

The POES satellites provide continuous operational measurement capability to be used for routine weather forecasting in accordance with NOAA program objectives. The POES meteorological imaging capability includes day/night images, cloud cover and cloud type, moisture patterns, cloud top and sea-surface temperature, and ice/snow melt interpretation. The POES satellites also provide a sounding capability for the determination of temperature and humidity profiles, atmospheric liquid water and total precipitable water vapor, atmospheric ozone profiles, and almost complete global coverage under most cloud conditions. In addition, POES measures electron and proton flux, provides Search and Rescue support, and Data Collection System support.

Significant enhancements for NOAA L-N' include many improvements and additions to the instrument complement, the most significant of which being the addition of the Advanced Microwave Sounding Units (AMSU) (A1, A2, and B). The accommodation of the AMSU instruments was the driver for many of the major design changes to the spacecraft bus. In addition, a new launch vehicle, Titan II, is being used for the first time for the NOAA-K, L, M missions, replacing the ATLAS-E. This change also forced significant modification to the spacecraft design.

On NOAA-N and N', the AMSU-B instrument is being replaced by the MHS, the digital tape recorders are being replaced with newly designed solid state recorders, and the Inertial Measurement Units (IMUs) are being replaced with new laser gyro IMUs. NOAA-NN' will fly on a new launch vehicle, the Delta II, instead of the Titan II. Table 1 lists instruments under development or procurement.

Table 1. POES Instruments Under Development/Procurement

Name	Instrument	Spacecraft	Objective	Source
AVHRR*	Advanced Very High Resolution Radiometer	All POES and MetOp	Cloud cover, surface temperature, aerosols, and vegetation index	ITT
HIRS*	High Resolution Infrared Radiometer Sounder	All POES and MetOp	Atmospheric temperature profiles	ITT
AMSU-A*	Advanced Microwave Sounding Unit-A	NOAA K-N' and MetOp	Atmospheric temperature profiles	Aerojet
AMSU-B	Advanced Microwave Sounding Unit-B	NOAA K-M	Moisture profiles	UK
MHS	Microwave Humidity Sounder	NOAA N-N' and MetOp	Moisture profiles	EUMETSAT
SBUV	Solar Backscatter Ultraviolet Radiometer	All PM orbit POES	Ozone concentrations	Ball Aerospace
SEM	Space Environment Monitor	All POES and MetOp	In-situ electromagnetic and particle environment	Panametrics (NOAA-K-N'); GFE from NOAA
DCS	Data Collection System	All POES and METOP	Environmental data from remote platforms	France
S&R	Search and Rescue	All POES and METOP	Aircraft and maritime emergency beacon system	Canada and France

*Indicates primary instrument. The non-redundant major failure of a primary instrument will likely result in a launch call-up.

The threshold requirement for the POES mission is the successful development and deployment of an operational series of spacecraft in support of routine numerical weather forecasting and global multi-spectral imaging. NOAA determines the replacement schedule based on the extent to which instruments or spacecraft subsystems fail on-orbit. Single satellite operation is acceptable during the replacement process.

POES spacecraft are required to support continuous operational measurements for daily meteorological forecasting as defined by NOAA. Each spacecraft is designed to meet all on-orbit performance requirements for a minimum period of two years. They typically operate for three-to-five years.

5.2 Level 1 Performance Requirements

The Level 1 requirements for the POES Program serve as the baseline for developing the lower-level performance requirements.

5.2.1 Coverage Requirement

Redundant Satellites

- One AM
- One PM

At least one satellite operational at all times.

5.2.2 Orbit Requirements

The satellite nominal orbit parameters for the two-satellite system are as shown below:

	Morning Orbit	**Afternoon Orbit**
Orbit Altitude (nominal)	833 km (450 nmi ± 10 nmi)	870 km (470 nmi ± 10 nmi)
Sun-synchronous Inclination	98.70° ± 0.15	98.86° ± 0.15
Orbit Period	101 minutes (min.)	102 min.

The satellites are required to operate at any Sun angle between 0° and 80°. For the nominal afternoon orbit, this angle restricts the ascending node to the interval between 1307and 1800 hours Local Solar Time (LST). For the nominal morning orbit, the descending node must occur in the interval between 0600 and 1120 hours LST. Figure 3 shows the orbit configuration for the two-satellite system.

5.2.3 Launch Vehicle

Titan II (NOAA-L, and M)
Delta II 7320 (NOAA N and N')

5.2.4 Mission Lifetime

Each spacecraft will be designed to meet all on-orbit performance requirements for a minimum period of two years.

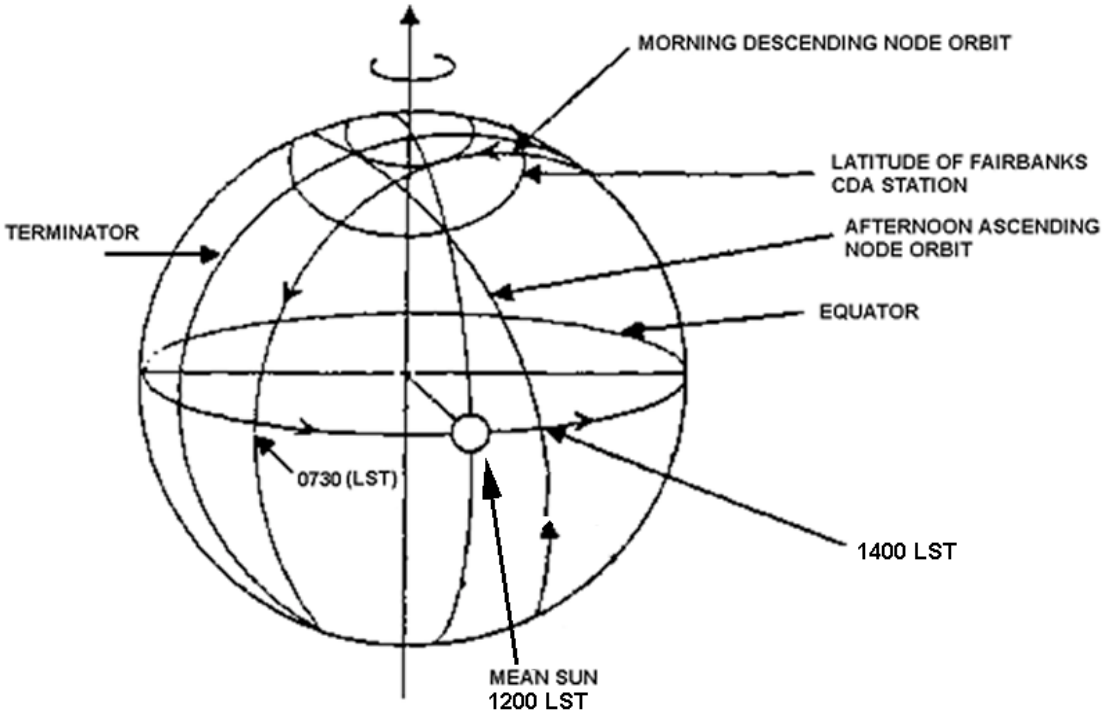

Figure 3. Two-Satellite Orbit Configuration

5.2.5 System Elements

- Flight Segment: The flight segment will include the spacecraft bus, its support subsystems, the operational instruments and the propulsion systems (L, and M only) required to transfer the spacecraft from polar transfer orbit to its final orbit.

- Launch Ground Segment: The launch ground segment will include the Vandenberg Air Force Base/Western Range (VAFB/WR), the Jet Propulsion Laboratory (JPL), the Deep Space Network (DSN), the Air Force Satellite Control Network (AFSCN), NASA Integrated Services Network (NISN), GSFC Network Control Center (NCC), the Flight Dynamics Facility (FDF), and the NOAA on-orbit ground segment.

- Operations Ground Segment: The operations ground segment will consist primarily of the NOAA Satellite Operations Control Center (SOCC) for satellite control, the NOAA Command and Data Acquisition (CDA) stations for supporting spacecraft operations, and the NOAA Central Data and Distribution Facility (CDDF) for data processing and dissemination.

5.2.6 Instrument Performance Specifications

- **AMSU-A1, A2** – The AMSU-A instrument measures scene radiance in the microwave spectrum. The data from this instrument is used in conjunction with the HIRS to calculate the global atmospheric temperature and humidity profiles from the Earth's surface to the upper stratosphere, approximately a 2 millibar pressure altitude (48 km or 28 mi). The data will

also be used to provide precipitation and surface measurements including snow cover, sea ice concentration, and soil moisture.

The AMSU-A is a cross-track, stepped-line scanning total power radiometer. The AMSU-A is divided into two physically separate modules, each of which operates and interfaces with the spacecraft independently. Module A-1 contains 13 channels and Module A-2 contains two channels.

The instrument has an instantaneous field-of-view (IFOV) of 3.3° at the half-power points providing a nominal spatial resolution at nadir of 48 km (29.8 mi). The antenna provides a cross-track scan, scanning $\pm$48.3° from nadir with a total of 30 Earth fields-of-view per scan line. The instrument completes one scan every 8 seconds.

- **AVHRR/3** – The AVHRR/3 monitors reflected energy in the visible and near-infrared (IR) portions of the electromagnetic spectrum to observe vegetation, clouds, lakes, shorelines, snow, aerosols, and ice. The instrument also determines the radiative energy from the temperature of the land, water, and sea surface, as well as the clouds above them.

  The AVHRR is a six-channel imaging radiometer that detects energy in the visible and IR portions of the electromagnetic spectrum. The instrument measures reflected solar (visible and near-IR) energy and radiated thermal energy from land, sea, clouds, and the intervening atmosphere. The instrument has an IFOV of 1.3 milliradians providing a nominal spatial resolution of 1.1 km (0.59 mi) at nadir. A continuously rotating elliptical scan mirror provides the cross-track scan, scanning the Earth from $\pm$55.4°from nadir. The mirror scans at six revolutions per second to provide continuous coverage.

- **HIRS/3** – The HIRS/3 is a 20-channel instrument that has IFOV of 1.3° providing a nominal spatial resolution at nadir of 18.9 km (11.7 mi). The antenna provides a cross-track stepped scan, scanning $\pm$49.5° from nadir with a total of 56 fields-of-view per scan. The instrument completes one scan line every 6.4 seconds. The HIRS scan profile has been modified to eliminate the viewing of the cold blackbody internal calibration target from the automatic calibration sequence. The additional time has been used to perform another scan (38 per calibration sequence) of the Earth.

- **SEM/2** – The SEM/2 provides measurements to determine the intensity of the Earth's radiation belts and the flux of charged particles at the satellite altitude. It provides the knowledge of solar terrestrial phenomena and also provides warnings of solar wind occurrences that may impair long-range communication, high-altitude manned operations, damage to satellite circuits and solar panels, or cause changes in drag and magnetic torque on satellites.

  The SEM/2 consists of two separate sensor units and a common Data Processing Unit (DPU). The sensor units are the Total Energy Detector (TED) and the Medium Energy Proton and Electron Detector (MEPED).

  The TED senses and quantifies the intensity in the sequentially selected energy bands. The particles of interest have energies ranging from 0.05 keV to 20 keV. The MEPED senses protons, electrons, and ions with energies from 30 keV to levels exceeding 6.9 MeV.

- **SBUV -** The SBUV/2 is a nonspatially scanning, spectrally scanning sounding radiometer. It is designed to measure scene radiance and solar spectral irradiance in the spectral range from 160 nm to 406 nm. In the discrete mode, measurements are made in 12 spectral bands from which the total ozone vertical distribution of the ozone is deduced. The sweep mode provides continuous spectral scan from 406 nm to 160 nm that is used primarily for solar spectral irradiance measurements.

5.2.7 Foreign Instrument Accommodation

- **Search and Rescue Instruments** – The Search and Rescue Repeater (SARR) and Search and Rescue Processor (SARP) are part of the international COSPAS-SARSAT system designed to detect and locate Emergency Locator Transmitters (ELTs), Emergency Position-Indicating Radio Beacons (EPIRBs), and Personal Locator Beacons (PLBs) operating at 121.5, 243, and 406 MHz. The NOAA spacecraft carry two instruments to detect these emergency beacons: the SARR provided by Canada and the SARP-2 provided by France. Similar instruments are carried by the Russian COSPAS polar-orbiting satellites.

  The SARR transponds the signals of 121.5, 243, and 406 MHz emergency beacons. However, these beacon signals are detected on the ground only if the satellite is in view of a ground station known as a Local User Terminal (LUT). The SARP detects the signal only from 406 MHz beacons but stores the information for subsequent downlink to a LUT. Thus, global detection of 406 MHz is provided.

  After receipt of information from a satellite's SARP or SARR, and LUT locates the beacons by Doppler processing. The 121.5 MHz and 243 MHz beacons are located with an accuracy of approximately 20 km, whereas the 406 MHz beacons are located with an accuracy of approximately 4 km. The LUT forwards the located information to a corresponding Mission Control Center which, after further processing, forwards the information to an appropriate Rescue Coordination Center, which effects search and rescue.

  The U.S. fishing fleet is required to carry 406 MHz emergency beacons. The 406 MHz beacons are also carried on most large international ships, some aircraft, and pleasure vessels, as well as on terrestrial carriers. The 121.5 MHz and 243 MHz beacons are required on many small aircraft with a smaller number carried on maritime vessels.

- **DCS** – Data collection platforms in the form of buoys, free-floating balloons, and remote weather stations transmit their data on a 401.65 MHz uplink to the spacecraft. The DCS measures environmental factors such as atmospheric temperature and pressure and the velocity and direction of the ocean and wind currents. The DCS collects and processes these measurements for on-board storage and subsequent transmission from the satellite.

  For free-floating telemetry transmitters, the system determines the location within 5 km to 8 km and "float" velocity to an accuracy of 1 meter per second (mps).

  The stored data is transmitted to the ground once per orbit. Subsequently, the data is sent to the French Centre at the Centre National d'Etudes Spatiales (CNES) in Toulouse, France, and the Service Argos Facility in Lanham, Maryland, for processing, distribution to users, and storage for archival purposes.

- **AMSU-B** – The AMSU-B is designed to allow the calculation of the vertical water vapor profiles from the Earth's surface to about a 200-millibar pressure altitude (12 km or 7.5 mi).

  The AMSU-B is a cross-track, continuous line scanning, total power radiometer and uses measurements of scene radiance in 5 channels. The instrument has an IFOV of 1.1° (at the half-power points). Spatial resolution at nadir is nominally 16 km (9.94 mi). The antenna provides a cross-track scan, scanning $\pm$48.95° from nadir with a total of 90 Earth fields-of-view per scan line. The instrument completes one scan every 2.66 seconds.

- **MHS -** The MHS is designed to allow the calculation of the vertical water vapor profiles from the Earth's surface to an altitude of about 15 km (9.4 mi).

  The MHS is a cross-track, continuous line scanning, total power radiometer and uses measurements of scene radiance in five channels. The instrument has an IFOV of 1.1110 (at the half-power points). Spatial resolution at nadir is nominally 16 km (9.94 mi). The antenna provides a cross-track scan; scanning ±50° from nadir with a total of 90 earth fields-of-view per scan line. The instrument completes one scan every 2.66 seconds.

5.2.8 Satellite Pointing and Stability Requirements

- Error < 0.2° for each axis.
- Roll error rate < + 0.015° per second
- Pitch and yaw error rate < +0.035 °

5.2.9 Facility Characteristics

Existing NOAA facilities will be used for on-orbit operations. Existing NASA and USAF facilities at the VAFB/WR will be used for launch operations.

6.0 Program Schedule

The polar meteorological program is conducted on a launch-as-needed basis and does not subscribe to a rigid set of predetermined fixed launch dates. Rather, the challenge for NASA is to conduct a satellite development program that is flexible enough to meet NOAA's requirements for operational data continuity and cost effectiveness involving maximum use of launched assets. NOAA is responsible for determining the need for satellite replacement, which is expressed in terms of Launch Need Dates (LNDs) and Planning Launch Dates (PLDs). The LNDs refer to the potential earliest need of the spacecraft, based on statistical gap analyses performed by NOAA.

The PLDs reflect a more likely launch date, assuming that the spacecraft and critical instruments remain functional for approximately four years in orbit. LNDs and PLDs are formally exchanged between NOAA and NASA at least twice annually and form the basis for the formal budget formulation process conducted by NASA.

NOAA attempts to use each spacecraft to its maximum capability. Spacecraft with a design life of 2 years are typically used for 3-5 years. The PLDs assume a nominal four-year replacement as specified by NOAA. Launch Availability Dates provide the program's earliest feasible launch for each spacecraft. Actual launch is dependent upon receipt of a call-up request from NOAA. NOAA's rescheduling allowed the stretch-out of the POES satellites to match the use of the remaining Defense Meteorological Satellite Program assets prior to the transition of both programs' responsibilities to NPOESS.

Table 2 contains the POES Mission Implementation Milestones.

Table 2. Mission Implementation Milestones

	Major Milestones		Mission			
	PCA	Program Plan	L	M	N	N'
1	Mission Confirmation Review	Mission Confirmation Review	N/A to POES	N/A to POES	N/A to POES	N/A to POES
2	Mission Design Review	Mission Design Review	9/89	9/89	2/99	2/99
3		First Instrument Delivery	9/95	6/96	7/98	12/98
4	Mission Operations Review[1]	Mission Operations Review	N/A to POES	N/A to POES	N/A to POES	N/A to POES
5		Last instrument delivery	9/99	8/00	10/00	10/01
6	Observatory I&T Start	Observatory I&T Start	2/96	1/97	2/99	3/00
7		Spacecraft/Ground System Basic Command and Telemetry Test[2]	8/96	11/97	1/01	11/01
8		Observatory End-End Data Flow Test (SlMs, Dress Rehearsal)[3]	L-60	L-60	L-60	L-60
9	Observatory Pre-Ship Review	Observatory Pre-Ship Review	2/00	L-90	L-90	L-90
10		Mission Readiness Review	7/00	L-45	L-45	L-45
11	Launch Availability Date	Launch Availability Date	N/A	3/01	12/02	12/04
12	Planned Launch Date	Planned Launch Date[4]	8/29/00	5/01	12/03	1/08
13		Observatory Checkout Complete (LEO)	9/00	L+30	L+30	L+30
14	Distribution of Cal/Val Data	Distribution of Cal/Val Data	12/00	L+90	L+90	L+90

[1] Flight Operations Readiness Review (FORR) held for NOAA-K as first in series. (Code 300 waived FORR on NOAA-L.) For NASA-directed portion of mission. NOAA is responsible for normal mission operations.

[2] First spacecraft electrical performance and evaluation test (SEPET) for each spacecraft

[3] Date is pre-launch end-to-end test for each spacecraft

[4] Planned launch dates from NOAA guideline. NOAA determines actual launch dates.

7.0 Program Resources

POES Program costs are prepared during each Program Operating Plan (POP) budget formulation activity in response to NOAA's most recent guidelines memo. These estimated program costs are contingent upon NOAA's ability to obtain funding through the budget process. NOAA provides funding guidelines, launch schedule information, and relevant technical direction to NASA by January 15 and June 15 of each year, with NASA's response due by March 15 and August 15 respectively.

8.0 Controls

8.1 Validation of Requirements

The POES Program performs a Reliability assessment to ensure that the NOAA-L, M, N and N' spacecraft designs are compatible with the requirements of the mission. The reliability requirements will follow the Reliability Program tasks delineated in "Quality Program Provisions for Aeronautical and Space System Contractors," (NASA Handbook (NHB) 5300.4 (2B-3), as tailored to the needs of the program and mission. Emphasis will be placed upon conducting (at the spacecraft/subsystem, subsystem/component, and the spacecraft/instrument interfaces) failure mode effect and criticality analyses (FMECAs); parts and materials applications reviews; worst-case analyses (emphasizing mission-critical stresses and design degradation); and trend analyses (through the testing phase) of key parameters. Previous reliability analyses will be used whenever possible for previously flown hardware.

8.2 Level 1 Requirements

Any proposal by the POES Program to change a Level 1 requirement or any failure to meet Level 1 requirements will be referred to the Lead Center Director at GSFC and to the Enterprise AA for appropriate action. For those issues requiring Level 1 decisions, the procedures defined in the "POES Configuration Management Procedure," S-480-83, will be used.

8.3 Cost and Schedule Control

NOAA provides formal direction to NASA at least twice per year on a special schedule to accommodate the NOAA/DOC budget schedule. In addition, schedules and funding requirements will always be somewhat flexible in order to respond to the on-orbit performance needs of the operational satellite program.

8.4 APA and Reserves Management Strategy

NOAA holds all Allowance for Programmatic Adjustment (APA). Reserves for the POES Program are held at the Program level and are used at the discretion of the Program Manager.

8.5 Updating the PCA

The POES Program Manager collaborates with HQ on updates to the Program Commitment Agreement (PCA) based on guidelines provided by NOAA.

9.0 Relationships to Other Programs and Agreements

9.1 Internal Programs and Agreements

The successful implementation of the POES Program is based on the fulfillment of the supporting internal NASA agreements in the areas of tracking resources, launch services, and overall program implementation shown in Table 3.

Table 3. Internal NASA Agreements

Type of Agreement	Organization	Agreement Subject	Date
Project Plan	GSFC	NOAA-K,L,M	Dec 92
Transition Plan	GSFC/KSC	Launch Services	Jan 98
Letter of Agreement (LOA)*	Code O (now Code M)	Tracking Services Support	Jun 94
Program Plan**	GSFC	NOAA-K/L/M/N/N'	March 1999

*The Code O Mission Requirements Request (MRR) acknowledgment letter constitutes an agreement in principle to the MRRs submitted by Code Y on the following date: NOAA-K, L, M MRR: Mar 1993. Tracking services support is not unique to the POES program, and therefore a separate cost commitment is not required. The LOA for POES also addresses the Space Operations Logistics Support that is unique to the combined POES and Geostationary Operational Environmental Satellite (GOES) programs. Because most of the Logistics Support is provided to the POES program, Code O's cost commitment is documented on the POES PCA, Table 3. Code O responsibilities have been transferred to Code M.

** NOAA-N, N' are operational gap fillers until the NPOESS program is operational.

9.2 External Programs and Agreements

NOAA and NASA have developed a unique working arrangement that integrates the specialized capabilities of each agency in providing space-borne environmental monitoring for the purpose of environmental forecasting. NOAA defines the requirements for operational measurement while NASA employs its experience in managing development of space-borne sensing systems. The implementation of the POES Program is based on the Basic Agreement and the MOA between NASA and the DOC as shown in Table 4.

Table 4. External NASA Agreements

Type of Agreement	Organization	Agreement Subject	Date
Basic Agreement	DOC	NASA/DOC roles in weather satellite programs	Jun 98
Memorandum of Agreement (MOA)	NOAA	POES Program	Apr 98
Memorandum of Understanding (MOU)	NASA GSFC/ NOAA NESDIS	NASA/NOAA roles in post-launch operations of POES	Oct 95
LOA	NASA/NOAA	Technology Transfer Guidelines for the Initial Joint Polar System (IJPS)	Oct 95

10.0 Acquisition Strategy

Not applicable because no new acquisitions are planned.

11.0 Commercialization Opportunities

There are no known commercial applications or products associated with POES data. NOAA freely disseminates the POES data.

12.0 Technology Assessment

12.1 New Technology Reporting

The contractor shall conduct periodic reviews to ensure that reporting of new technology is accomplished in accordance with applicable NASA regulations.

13.0 Data Management

All operational data products required for postlaunch checkout and NOAA operations will be the responsibility of NOAA and will be developed and disseminated by NOAA's Central Environmental Satellite Computer System (CEMSCS) at the World Weather Building in Camp Springs, Maryland, and the NOAA/Space Environment Center (SEC) in Boulder, Colorado. These data are made available to NASA researchers and others for purposes of research and environmental applications.

Significant new information in the field of terrestrial applications and sciences is reported in a variety of journals and books. Compilations of operational applications satellite data, as well as a large variety of data products (e.g., pictures and maps) for particular purposes/uses are archived at widely scattered national centers and made available to users on reimbursable leases.

14.0 RISK MANAGEMENT

NOAA attempts to use each spacecraft to its maximum capability. Production schedules are typically established to ensure a backup spacecraft is available for launch call-up at all times. Spacecraft with a design life of 2 years are typically used for 3 to 5 years. NOAA is responsible for budgeting and supplying financial resources to the program. Resource limitations on the program sometimes limit spacecraft production schedules. Such conditions typically result in program stretch-out with associated budget implications. The ability to obtain these resources and subsequently meet availability dates is subject to budgetary approval of the Department of Commerce, Office of Management and Budget, and Congress. NOAA L-N' include significant enhancements in instrumentation with commensurate spacecraft modifications. Risk mitigation efforts include: the early start of development efforts; the use of NASA personnel at contractor facilities; quality and technical audits; and tiger teams when necessary.

The primary risk in meeting the major POES requirements relates to the continuity of data from at least one spacecraft. For this reason a nominal two-spacecraft constellation is employed with satellites replaced when they fail. A failure is considered to be the failure of the spacecraft or AMSU-A1, HIRS or AVHRR instruments. NOAA would then initiate a 150-day, for Titan II, and 120-day, for Delta, call-up for the next satellite to be launched.

15.0 Logistics

Major logistics problems are not anticipated. The program uses the Integrated Logistic Support for arrangements of transportation to the spacecraft and the associated ground support equipment to the WR.

16.0 Test and Verification

16.1 Overview

The Performance Assurance Program for NOAA-L, M, N and N' is based upon the following:

- Management of Government Quality Assurance Functions for NASA Contracts," NHB 5300.4(2B-3).
- Goddard Procedures and Guidelines (GPG) 5340.2 "Control of Nonconforming Product."
- GPG 5310.2F, "Safety, Reliability, and Quality Assurance Contract Provisions-The Goddard Space F1ight Center Procurement and Identification of Items for Space Flight Use."
- GPG 5340.3, "Preparation and Handling of Alerts and Safe Alerts."

The Performance Assurance Program for NOAA-K, L, M, N and N' addresses both the flight and ground segments including spacecraft, instrument payload, airborne and ground support equipment and systems, and their interfaces for the life-cycle of the Program, including design, fabrication, integration, test, launch, deployment, checkout, and subsequent orbital anomalies.

16.2 Performance Verification

16.2.1 Test and Analytical Program

A formal Test and Analytical Program will be conducted to provide assurance that the hardware is capable of surviving and performing its mission within specification under the various environments to which it will be subjected. This program will demonstrate the validity of design, positive margins, quality of workmanship and materials, and satisfactory performance under the various mission environments with appropriate factors of safety. It will also screen the hardware for latent malfunctions. The program will include functional tests at the box and system levels. These tests will be conducted under ambient and simulated mission conditions, including factors of safety as applicable. Verification activities will demonstrate compliance with the system safety requirements as appropriate.

16.2.2 Compatibility Tests and Simulations

Tests will be conducted on NOAA- L, M, N and N' to verify transmitter compatibility with all supporting ground systems, and receiver capability with NOAA and DSN ground systems. End-to-end testing will be conducted to ensure command and telemetry capability with the NOAA control center. Recorded and real-time satellite data will be relayed through the operational

ground system to verify data compatibility with the NOAA ground system and data processing facility. Mission simulation exercises are conducted to validate nominal and contingency mission operating procedures and provide for operator familiarization training.

17.0 Reviews

17.1 Headquarters Reviews

- The POES Program Manager will be responsible for supporting the preparation of the Quarterly Status Reviews (QSRs) to the Headquarters PMC.
- The External Independent Readiness Reviews (EIRR) is conducted by a team of highly knowledgeable specialists from organizations outside of the advocacy chain of the program. The team is generally from organizations outside of NASA. The results, including identification of risks that NASA faces as it proceeds with the program and suggested actions to reduce or mitigate risk, will be used by the Enterprise AA in determining program readiness to proceed to the next stage.
- The Mission Readiness Reviews (MRR) is co-chaired by the AA/ES or his designee and the GSFC Center Director. It is held following the Goddard Center Director Review.

17.2 GSFC Reviews

17.2.1 Spacecraft Reviews

A series of POES Program flight assurance reviews for the NOAA-L, M, N and N' spacecraft will be conducted in accordance with "Spacecraft Design Review Program," GPG 8700.4. The Flight Assurance reviews will involve a team of technical specialists, selected on a Centerwide basis by the Director of Flight Assurance, a NOAA representative, and a chairman selected from the Systems Review Office. The following NOAA spacecraft reviews are planned or have been conducted (*).

- (*) The Systems Concept Review (SCR) will cover the flight and ground segments of the Program and its interaction with the total system. The SCR includes consideration of how the major elements of the overall system work together. This review, which also evaluates the design approaches and operational concepts, will occur early in the Execution Phase after the system contract has been awarded.
- (*) The Preliminary Design Review (PDR) will occur early in the design phase prior to the manufacture of engineering hardware. When applicable, it includes results of breadboard testing.

- (*) The Critical Design Review (CDR) will occur after the design has been frozen, but before assembly starts on the flight and ground segment hardware. The topics include design execution, test plans for the flight, ground and system segments, and the results of engineering model testing.
- The Pre-Environmental Review (PER) will occur before environmental testing of the flight hardware. The primary purpose is to establish the readiness of the hardware for test and to evaluate the plans for environmental testing and calibration.
- The Pre-Ship Reviews (PSR), takes place before shipment of the flight segment to the launch base. Its main purpose is to evaluate the equipment performance during testing. This review is updated to include significant events that occur during prelaunch preparation at the launch base.
- The Flight Operations Reviews (FOR), which will occur approximately 6 months prior to launch, will emphasize the final orbital operations plans, as well as the compatibility of the observatory with ground support equipment and ground network, including summary results of the network compatibility tests.
- The Flight Readiness Review (FRR), chaired by the Director of Flight Assurance, will be held approximately 3 days prior to launch. This Review is to assess the overall readiness of the total system to support the flight objective of the mission.

17.2.2 Instrument Reviews

Each instrument for the NOAA-L, N, N, N', and MetOp missions is subject to contractor and/or GSFC review programs. These reviews are to include the design and testing of the instrument. The POES Program Office and the Systems Review Office in the Office of Flight Assurance will jointly develop a review program for the entire NOAA instrument complement. The following NOAA instrument reviews are planned or have been conducted (*):

- (*) PDR
- (*) CDR
- PER
- The PSR occurs prior to each instrument delivery to the spacecraft prime contractor. Its main purpose is to evaluate instrument performance during acceptance testing.

17.2.3 System Safety

System safety, as it applies to flight equipment, will be an agenda item for each of the spacecraft and instrument reviews in the review program. Its consideration will serve to support the total System Safety Review Program.

17.2.4 Air Force Satellite Control Network

Periodic reviews will be conducted with the AFSCN to ensure compatibility between the NOAA-L, M, N, and N' spacecraft and the AFSCN network. AFSCN will conduct a review of ground system readiness prior to launch.

17.2.5 National Oceanic and Atmospheric Administration

NOAA will participate in the spacecraft and instrument reviews.

17.2.6 JPL/Deep Space Network

JPL will conduct a Ground Systems Readiness Review prior to launch.

17.3 GSFC Management Reviews

17.3.1 Monthly Coordination Review (MCR)

The Program Manager makes regularly scheduled monthly Program presentations to the Director of Flight Programs and Projects. These reviews cover all significant aspects of program status, including technical progress and management areas such as funding and manpower expenditures versus plan. Emphasis is placed upon defining problem areas and applying the necessary measures to resolve them. These reviews are attended by representatives from the Office of the Chief Financial Officer, in addition to the FPPD staff.

17.3.2 Monthly Status Review (MSR)

The Program Manager makes MSR presentations to the Center Director or his designee and senior GSFC management. These reviews cover all significant aspects of the technical and resources status of the Program.

17.4 Contractor Review Program

In addition to the reviews described above, contractors that provide NOAA-K, L, M, N and N' hardware and software will conduct a series of packaging and design reviews for all designs within the components and subsystems and at the payload level of assembly of both flight and ground segments. In addition to the normal function reviews for all technical disciplines, these reviews will also stress packaging and manufacturing techniques and processes. Summaries of discussions, as well as decisions reached at these reviews, will be provided to the Program Office. The Program Office and Flight Assurance Office may participate in these reviews; such reviews are in addition to the NASA reviews described above.

18.0 Tailoring

NOAA controls the program objectives, requirements, schedule, and funding for the POES Program. NOAA provides formal direction to NASA at least twice per year on a special schedule to accommodate the NOAA/DOC budget schedule. Schedules and funding requirements will always be somewhat flexible in order to respond to the on-orbit performance needs of the operational satellite program. To ensure compliance with NPG 7120.5A and consistency between the PCA and Program Plan, while meeting our customer's requirements in a timely manner, the schedule commitments and cost commitments will be updated at least twice per year to ensure they reflect the latest NOAA requirements.

Schedule and cost commitment changes will be documented in the Program Plan activities log and shall not require signature approval by the AA. The Center Director's signature on the

formal transmittal letter to NOAA and the AA's concurrence shall constitute approval of cost and schedule commitments. Any other changes to the Program Plan would require the AA's signature.

Acronyms and Abbreviations

µm	micrometer
AA	Associate Administrator
AFSCN	Air Force Satellite Control Network
AMSU	Advanced Microwave Sounding Unit
APA	Allowance for Programmatic Adjustment
AVHRR	Advanced Very High Resolution Radiometer
CDA	Command and Data Acquisition
CDDF	Central Data and Distribution Facility
CDR	Critical Design Review
CEMSCS	Central Environmental Satellite Computer System
CNES	Centre Nationale d'Etudes Spatiale
DCS	Data Collection System
DOC	Department of Commerce
DSN	Deep Space Network
ELT	Emergency Locator Transmitter
EPIRB	Emergency Position Indicating Radio Beacons
EROS	Earth Resources Observation System
ES	Earth Science
ESA	European Space Agency
EUMETAT	European Organization for the Exploitation of Meteorological Satellites
eV	electron-volt
FDF	Flight Dynamics Facility
FMECA	Failure Mode Effect and Criticality Analysis
FOR	Flight Operations Review
FORR	Flight Operations Readiness Review
FPPD	Flight Programs and Projects Directorate
FRR	Flight Readiness Review
FTE	Full-Time Equivalent
GFE	Government Furnished Equipment
GHz	Gigahertz
GOES	Geostationary Operational Environmental Satellite
GPG	Goddard Procedures and Guidelines
GSFC	Goddard Space Flight Center
HIRS	High Resolution Infrared Radiation Sounder
HQ	Headquarters
IFOV	Instantaneous Field-of-View
IJPS	Initial Joint Polar System
IMU	Inertial Measurement Unit
IR	Infrared
JPL	Jet Propulsion Laboratory
K	Kelvin
keV	Kiloelectron-volt
km	kilometer
KSC	Kennedy Space Center
LEO	Launch and Early Orbit
LND	Launch Need Date
LOA	Letter of Agreement
LST	Local Solar Time
LUT	Local User Terminal
MCR	Monthly Coordination Review
MEPED	Medium Energy Proton-Electron Detector
MetOp	Meteorological Operations
MeV	Megaelectron-volt
MHS	Microwave Humidity Sounder
MHz	Megahertz
min	minute
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MRR	Mission Readiness Review, Mission Requirements Request
MSR	Monthly Status Review
NASA	National Aeronautics and Space Administration
NCC	Network Control Center
NEΔT	Noise Equivalent Temperature Difference
NESDIS	National Environmental Satellite, Data, and Information Service
NHB	NASA Handbook
NISN	NASA Integrated Services Network
nmi	nautical mile
NOA	New Obligation Authority
NOAA	National Oceanic and Atmospheric Administration
NPG	NASA Procedures and Guidelines
NPOESS	National Polar-orbiting Operational Environmental Satellite System
PCA	Program Commitment Agreement
PDR	Preliminary Design Review
PER	Pre-Environmental Review
PLB	Personal Locator Beacon
PLD	Planning Launch Date
PMC	Program Management Council
POES	Polar Operational Environmental Satellites
POP	Program Operating Plan
PSR	Pre-Ship Review
QSR	Quarterly Status Review
R&D	Research and Development
S&R	Search and Rescue
SARP	Search and Rescue Processor
SARR	Search and Rescue Repeater
SBUV	Solar Backscatter Ultraviolet Radiometer
SCR	Systems Concept Review

SEC	Space Environment Center	UK	United Kingdom
SEM	Space Environment Monitor	UPN	Unique Project Number
S/N	Signal-to-Noise	USAF	United States Air Force
SOCC	Satellite Operations Control Center	VAFB	Vandenberg Air Force Base
SSP	Sub-Satellite Point	VHF	Very High Frequency
TED	Total Energy Detector	WR	Western Range
Temp	Temperature		